Master project, 2023 – 2024

Study of Magnetic Barkhausen Noise (MBN) under residual stress :

Application to EDF power plant tubes.

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Context

Tubes in power generation plants present residual mechanical stresses resulting from manufacturing processes, which can promote cracking of the material. There are several methods to characterise the residual stress state: by X-ray diffraction (XRD), acoustic waves, perforation, etc. These methods do not or only destructively provide an in-depth stress profile.

Otherwise, it is well known that residual stress affects the magnetization processes in ferromagnetic materials (coercivity, permeability, MBN, distribution of eddy currents, etc.). This fact can be exploited so that by considering the magnetization mechanisms such as MBN analysis, the amount of residual stress can be estimated. This can be an alternative to other methods for estimating the residual stress.

Methodology

• Bibliographic study of the link between physical properties and MBN in ferromagnetic materials.

• Experimental characterization of EDF tube samples.

- Mechanical characterization: measurement of residual stress, hardness, yield stress, grain size, etc.

- Magnetic and electrical characterization: measurement of electrical conductivity (four point method) and magnetic properties (mini-SST).

• Modelling of MBN in relation with magnetic properties (hysteresis) and the magneto-mechanical effect.

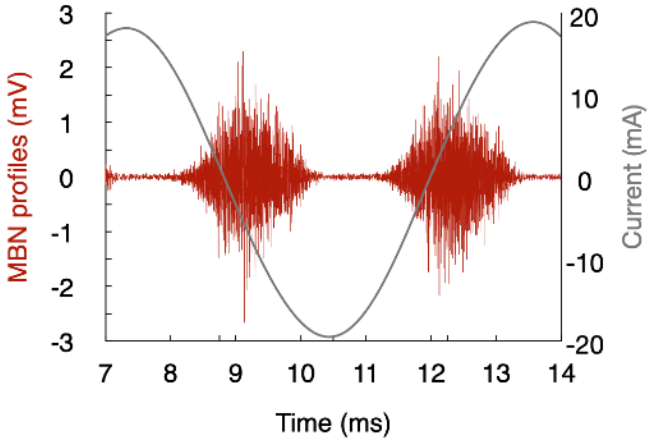

Fig.1. Typical MBN signature of a ferromagnetic steel (from M. Dherbécourt PhD thesis, L2EP, 2022).

Objectives

• Provide responses about the link between MBN signatures and mechanical properties.

• Development of a first approach of modelling of MBN.

Key words

Magnetic Barkhausen Noise (MBN), ferromagnetic materials, hysteresis, power plant tubes, residual stress.